# Use of multi-model convective-scale ensembles for high-profile rainfall cases over the UK

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with thanks to:

Alan Hally, James Fannon (Met Éireann)

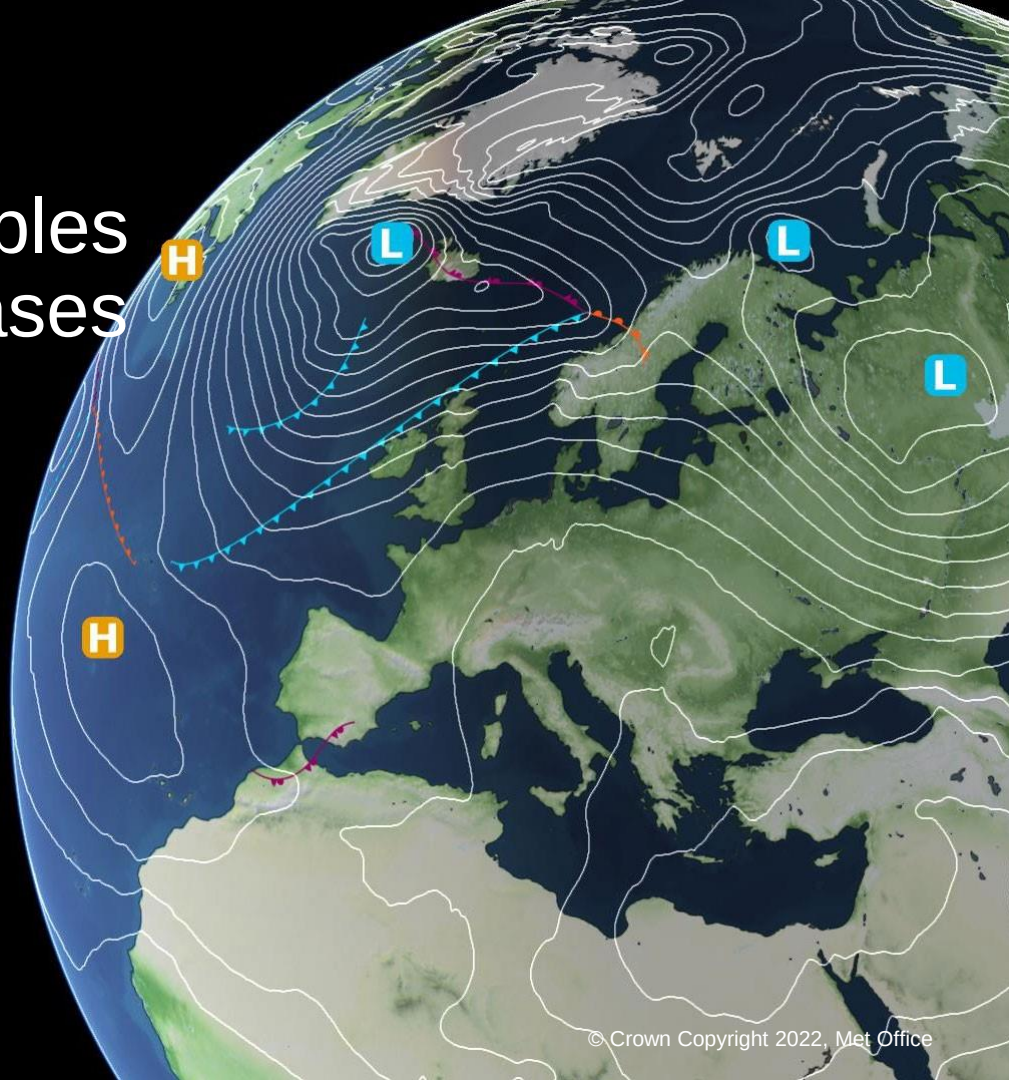
Henrik Feddersen (DMI)

Francois Bouttier (Meteo-France)

SRNWP-EPS lead (Alfons Callado Pallares)

Further thanks to Stephen Gallagher for supporting the archives of MOGREPS-UK data

44th EWGLAM 29th SRNWP, Brussels, 26-29 September 2022



# Contents

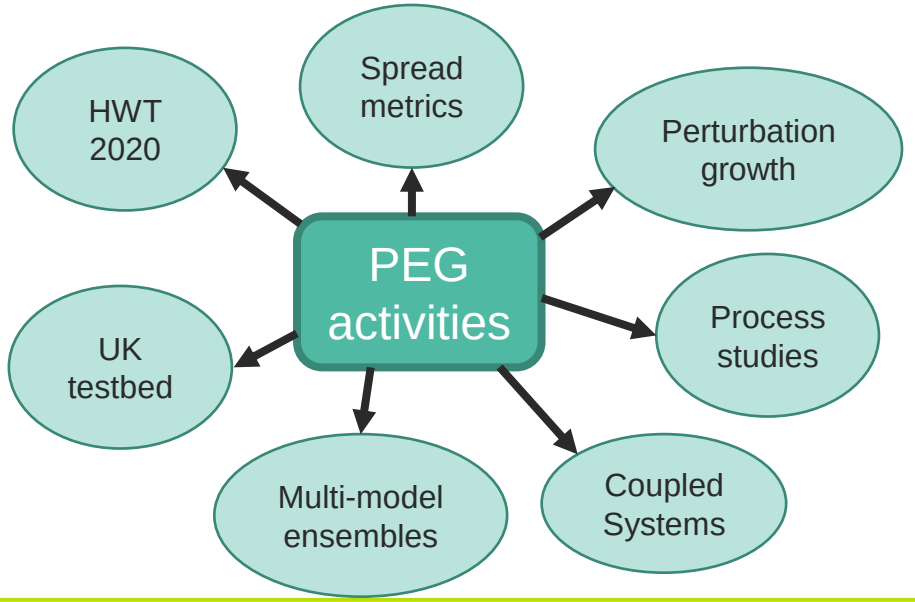
- Ensemble research – PEG work – ensemble strategy
- Motivation for using other ensembles – operations guidance
- Research examples for high-impact rainfall summer cases
- Conclusions
- Challenges and Opportunities ahead

# MOGREPS-UK Ensemble Spread PEG

Main purpose: To tackle the lack of spread in MOGREPS-UK *as experienced by operational meteorologists*

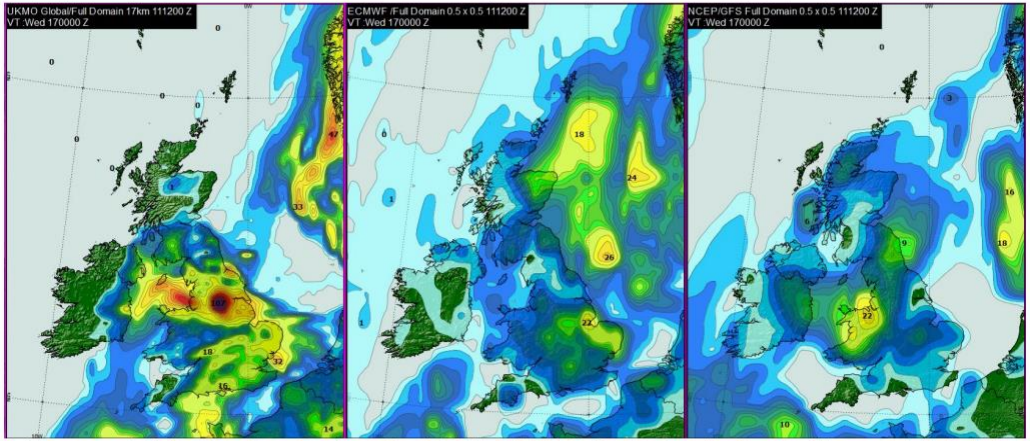
## Aims

- Identify the challenges of using convective-scale ensembles for operational meteorologists
- Quantify subjectively and objectively the lack of ensemble spread in MOGREPS-UK
- Develop our understanding of the nature of ensemble spread at the convective scale – how do we define 'useful spread'?
- Identify and explore key areas of development for improving ensemble spread
- Provide guidance for the future development and application of MOGREPS-UK




Anne McCabe, Aurore Porson, Nigel Roberts, David Flack, Sana Mahmood, Carlo Cafaro, Steve Willington, Stuart Webster

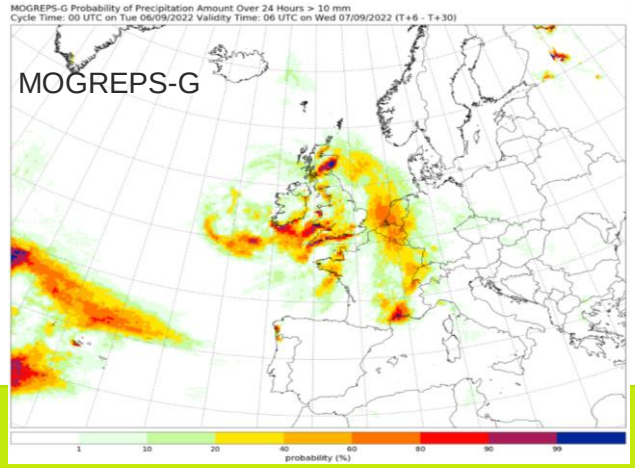
# Multi-model use in guidance

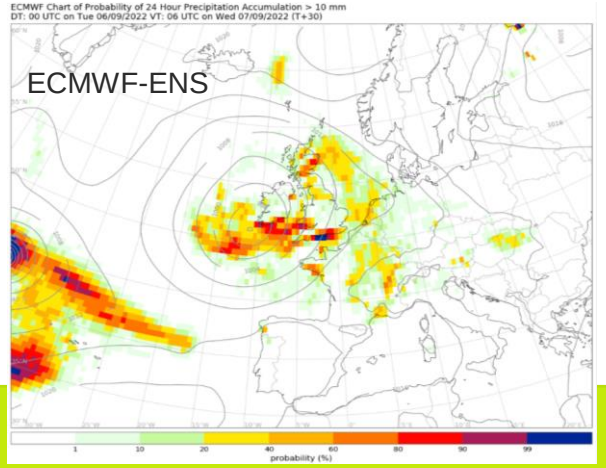



***24 hour precipitation for Tuesday from the 11/12Z GM-EC-GFS showing the focus of heavy rainfall shifted further S. Note that the GM more so than other models and modifications have been made to slow this.***

The process of using multi model is well embedded within the forecasting process for the global deterministic models

Efforts in place to make use of multiple global ensembles in forecasting process too (credit to Rob Neale and Helen Titley).



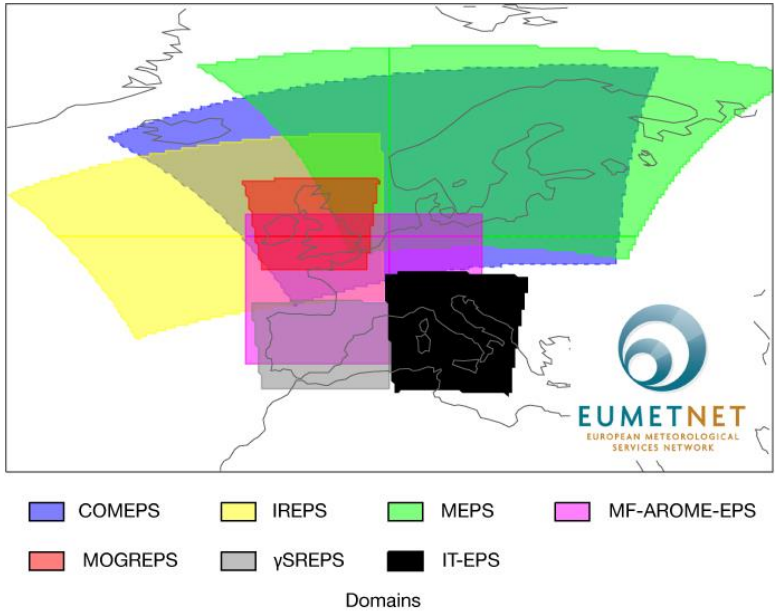



# Accessing other convective-scale ensemble data

Project coordinated by SRNWP-EPS

Callado-Palares A. et al., Convection-permitting ensemble database hosted at ECMWF, 2021. Retrieved from https://www.ecmwf.int/en/newsletter/166/news/eumetnet-convection-permitting-ensemble-database-hosted-ecmwf

Data archived from June 2020 to December 2023



# Application to set a selected cases (16 high-profile and/or high priority cases)

- No bias correction because we focus on raw model characteristics. Operational meteorologists prefer handling raw model data for scenario-based analysis (no “black box” ideally).
- Different view to some here: usefulness to the bench is here prioritised as opposed to equal likelihood between members through post-processing correction/calibration
- Cases based on **D**aily **F**orecast **A**ssessment guidance (by Adrian Semple) and testbeds

# Case 1: 25th July 2020

Differences noted in characteristics.
But potential value to guidance on how to optimise this forecast bust is low.

Met Office

# Extracted from DFARM reports

This is a forecast bust which has impacted the UKV, M-UK, and the GM.

ACTION: This is a forecast bust which is possibly related to uncertainties in the accurate development of the short-wave upper troughs driving the frontal wave. As such it is a case that is understandable to have a higher degree of forecast error in the GM and UKV. However this does not appear to be reflected in the ensemble.

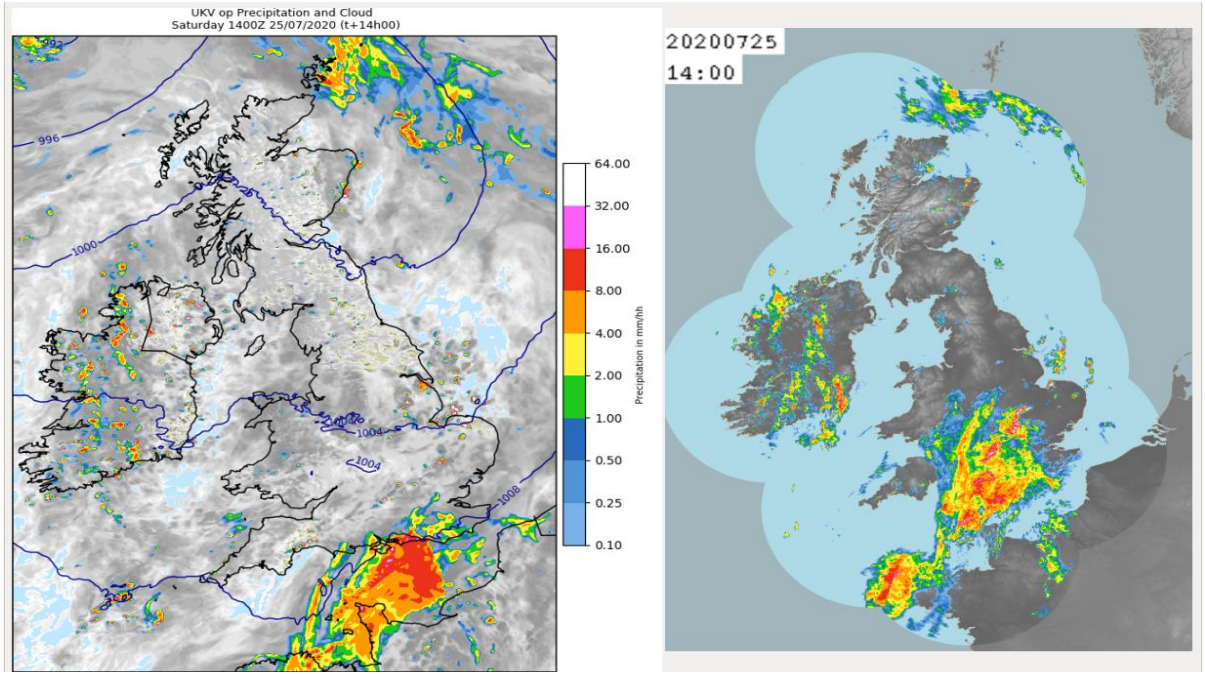
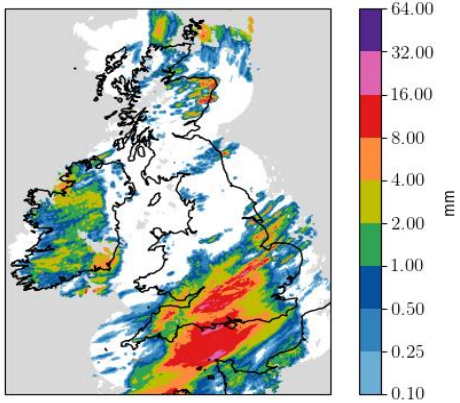



*Figure 33 UKV 00Z 25th July 2020 T+14 showing very poor UKV development of frontal wave ppn.*

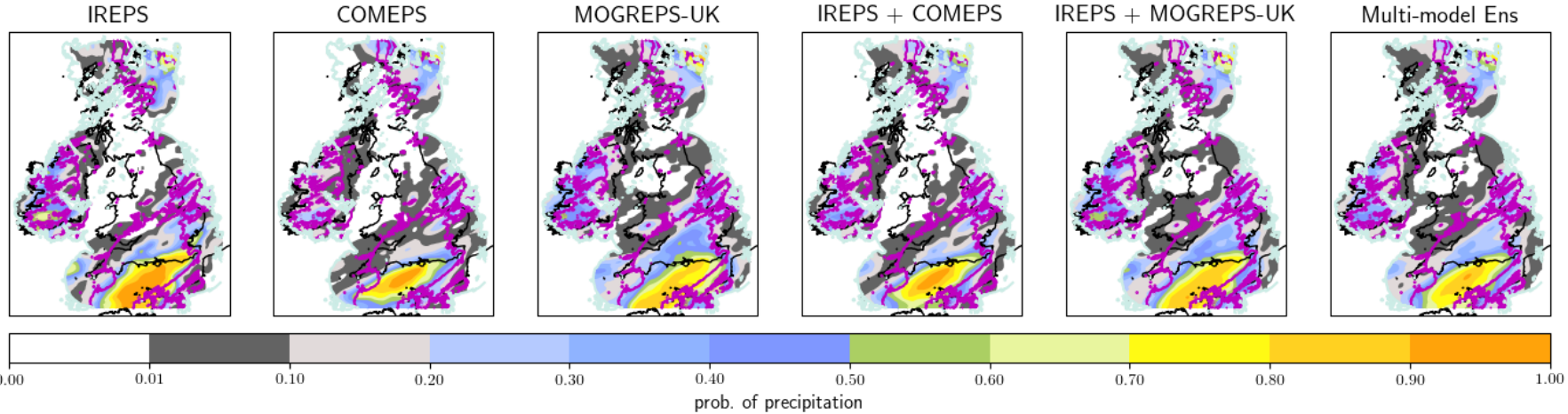
Courtesy of Adrian Semple

Met Office

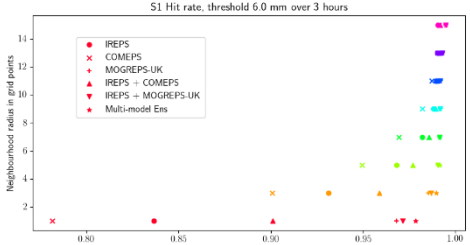
Radar accumulation over 3 hours valid at 20200725 15 UTC

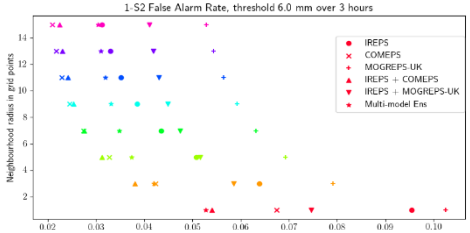


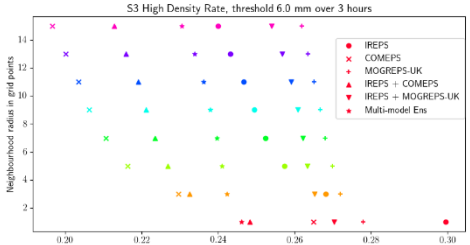

Prob 3 hourly Rain Accum 1.0 (mm)
20200725 at 15 UTC from 20200725 at 00 UTC

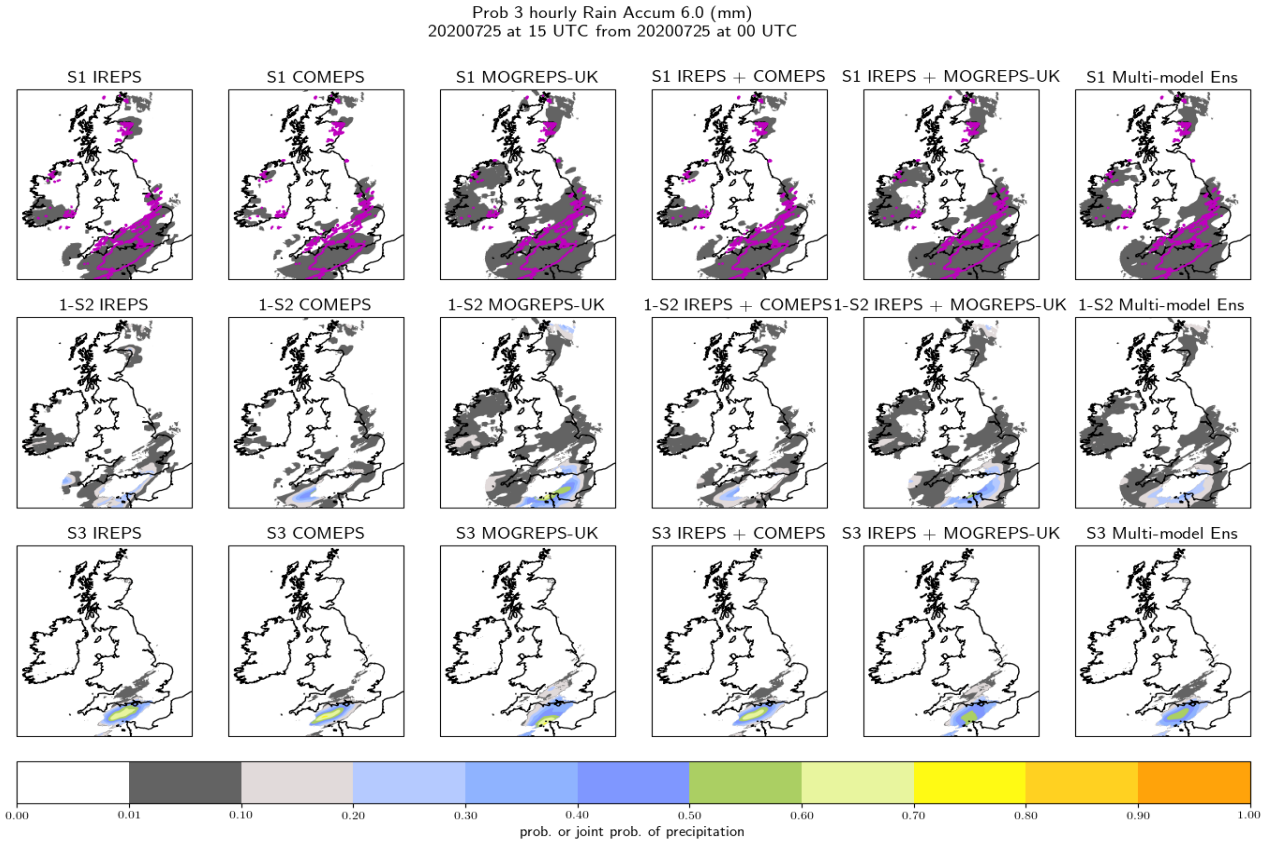


Met Office



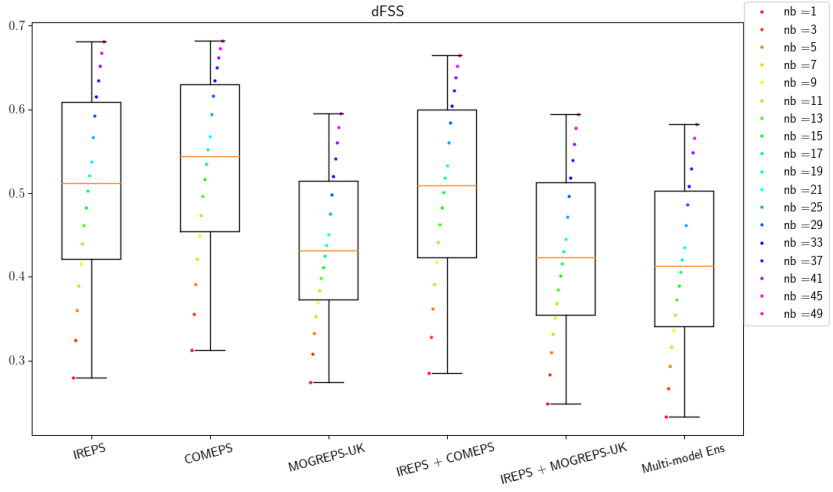



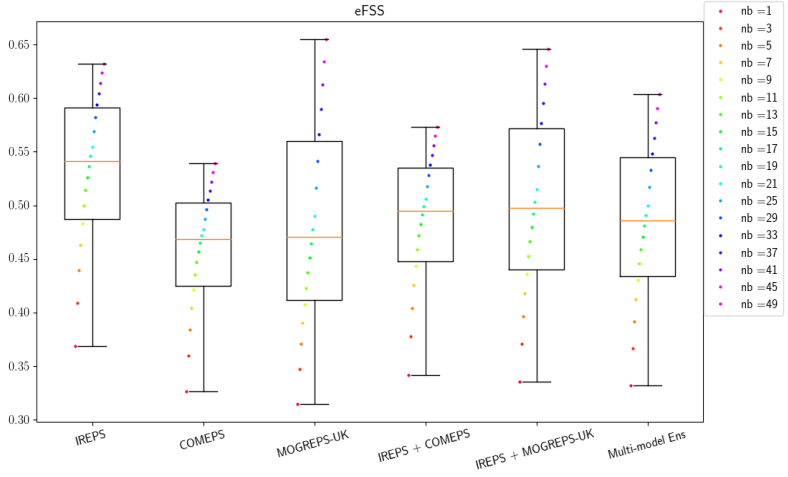



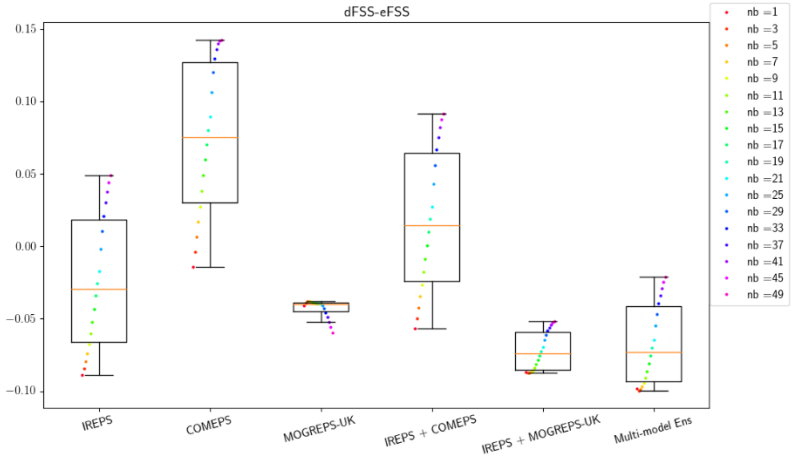




Subjective metrics (publication on the concepts behind these metrics in preparation, led by Nigel Roberts)

# FSS metrics. Valid at 15 UTC, threshold = 6 mm

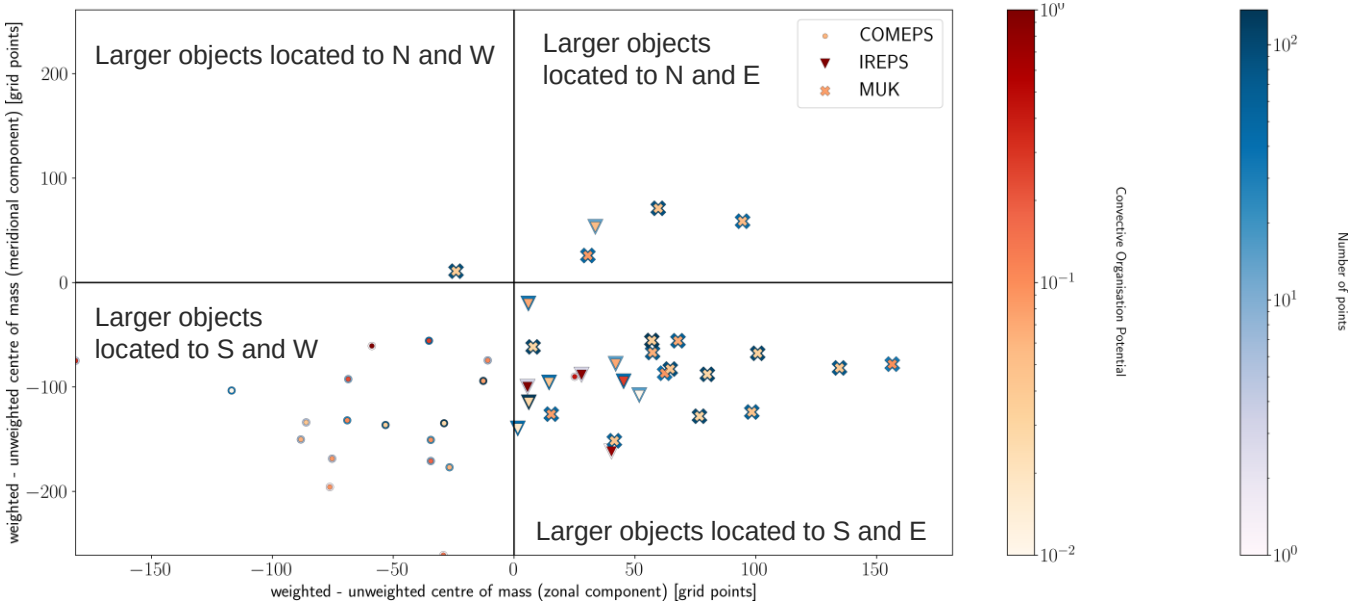



On this occasion, all three ensembles are fairly well balanced regarding the dispersion and spread. Note the different sensitivity to neighbourhood scales for MOGREPS-UK

# Fragmentation of Convection (6 mm in 3 h): 15 UTC 25 July 2020



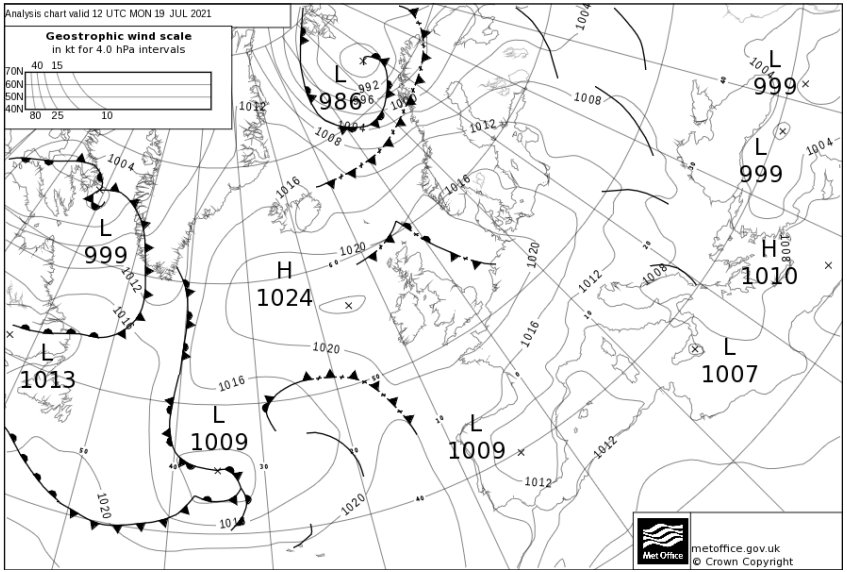

- Darker blue = more objects
- Darker red = more fragmented
- Event coming in from boundaries in S of domain for all (hence S preference of centre of mass displacement from organisation)
- Some grouping based on centre of mass displacement by organisation by model: MOGREPS E, IREPS central, COMEPS W
- MOGREPS-UK less spread in number and organisation potential

Courtesy of David Flack

# Case 2: 19th July 2021

High potential value to guidance. Issue with model characteristics in UM convective-scale physics

Met Office




This clearly shows a known UKV model characteristic in the UKV generating far too any showers. Profiles show an unusually poor fit in both A and B – both are too warm in the PBL and both lack the cap at 850hPa. Both are too moist above this, probably as a result of erroneous mixing as a result of lack of inversion.

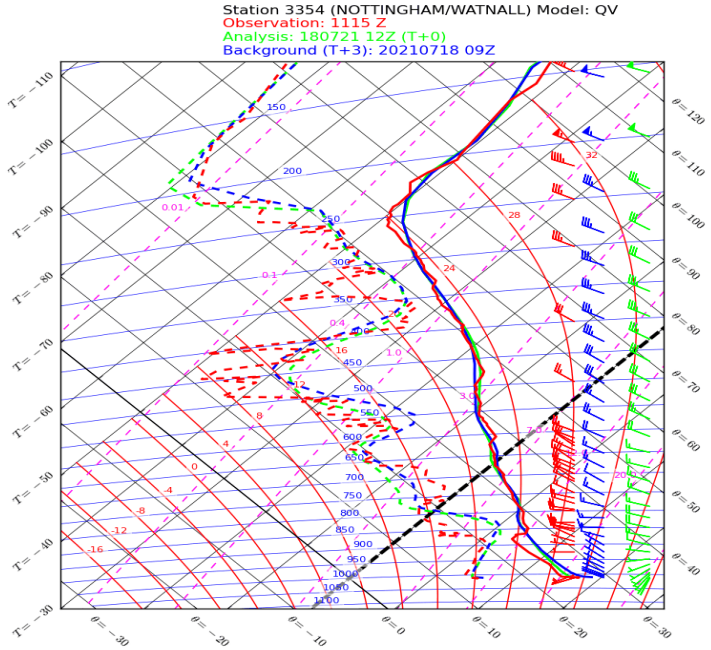
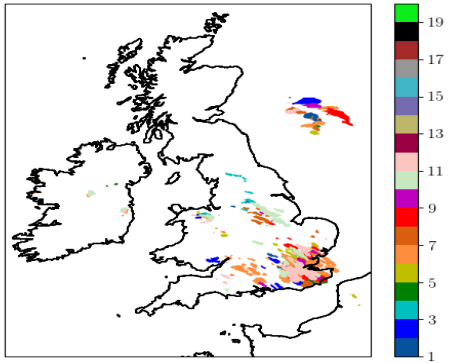



*Figure 18 Ascents at 12Z at Nottingham clearly show that the model completely lacks the capping inversion at 850hPa and is also far too warm below this. There are many other poor fits – a poor analysis and background. Note the temp error and superadiabat at the surface also.*

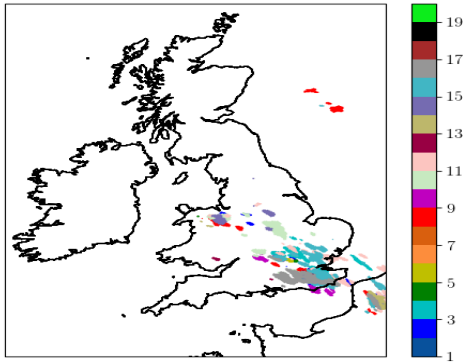
Also linked with 18th July 2021DFA entry, Adrian Semple

Met Office

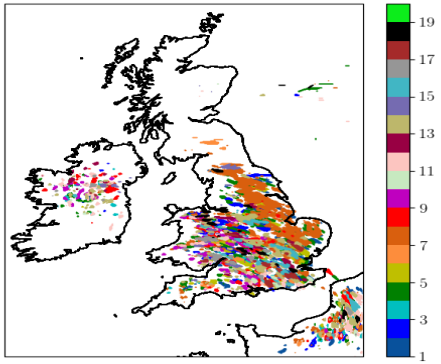
IREPS 20210719 at 15 UTC from 20210719 at 00 UTC
paintball over 1 mm over 3 hours



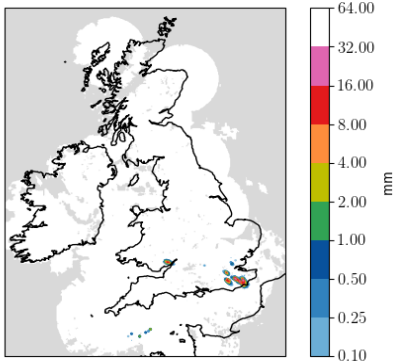

COMEPS 20210719 at 15 UTC from 20210719 at 00 UTC
paintball over 1 mm over 3 hours



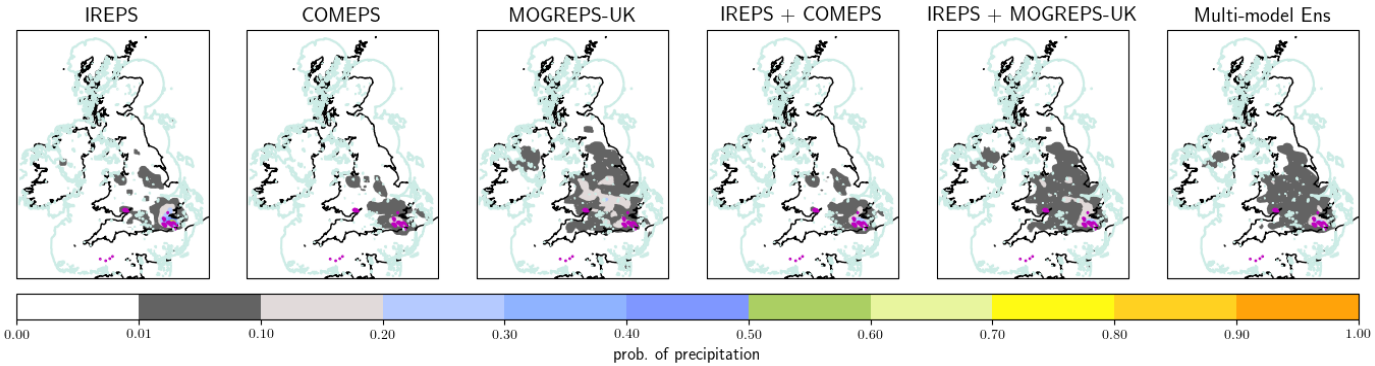

MOGREPS-UK 20210719 at 15 UTC from 20210719 at 00 UTC
paintball over 1 mm over 3 hours




Radar accumulation over 3 hours valid at 20210719 15 UTC




Prob 3 hourly Rain Accum 1.0 (mm)
20210719 at 15 UTC from 20210719 at 00 UTC

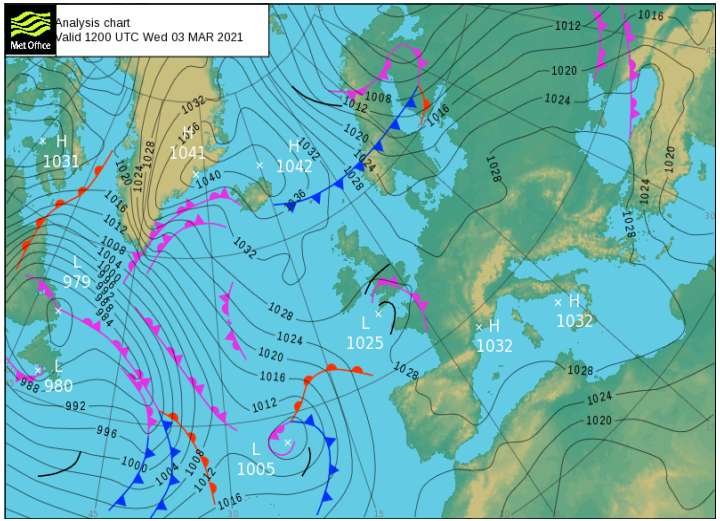


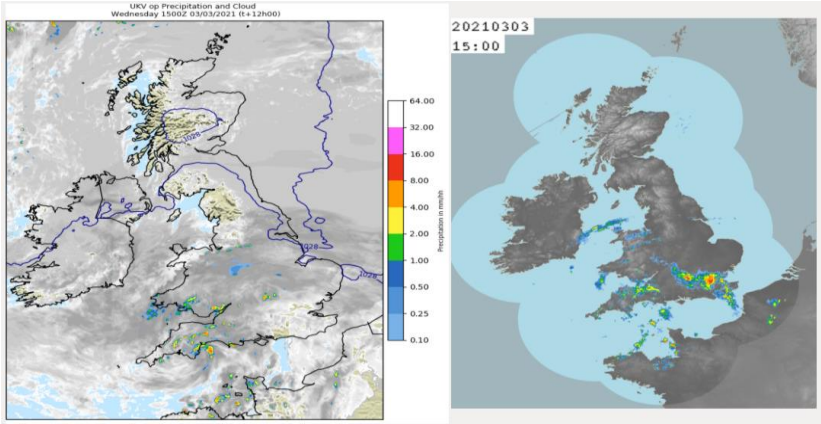
# Case 3: 3rd March 2021

High potential value to guidance as misplacement of convective rainfall despite global guidance being satisfactory

# Extracted from DFARM reports

Mostly cloudy with easterly flow producing poor boundary layer conditions and a small-scale upper vortex moving eastwards across southern UK bringing showers/smaller-scale bands of rain to the southern or so half of the UK.

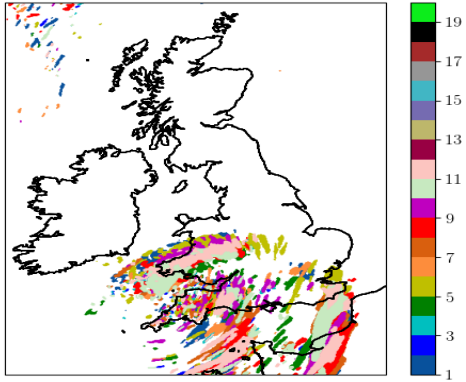


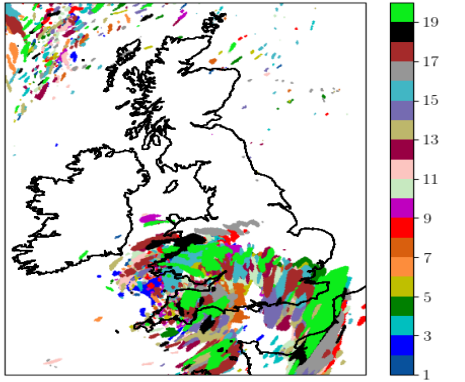

*UKV 03Z 3rd March 2021 T+12. UKV continues to lack any frontal activity along the occlusion in the south. Performance in GM however noted satisfactory*

Courtesy of Adrian Semple

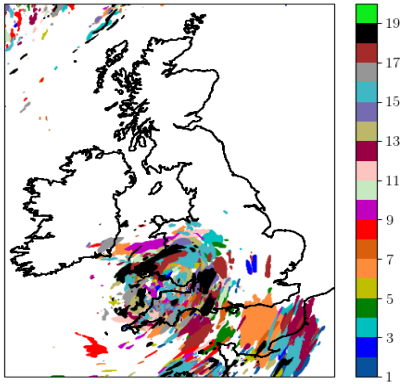
IREPS 20210303 at 15 UTC from 20210303 at 00 UTC
paintball over 1 mm over 3 hours



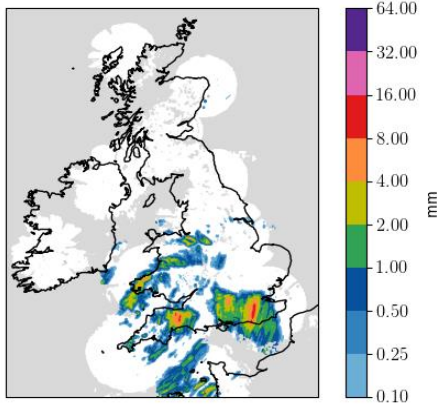

COMEPS 20210303 at 15 UTC from 20210303 at 00 UTC
paintball over 1 mm over 3 hours



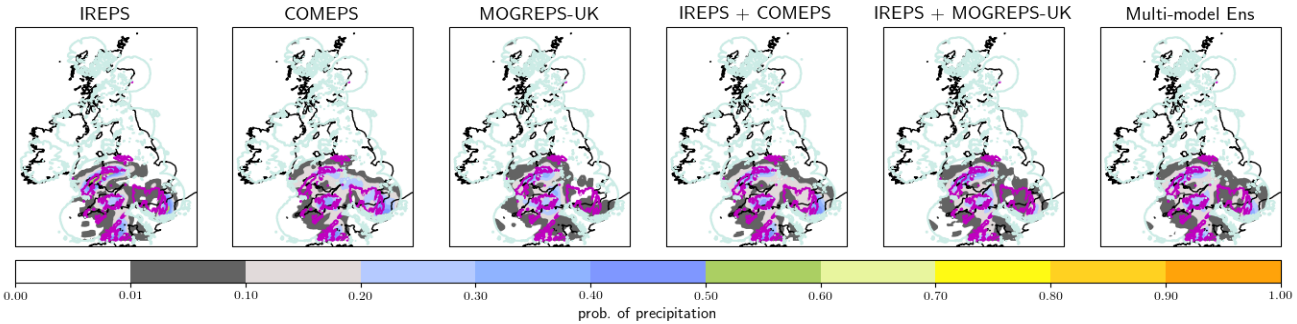

MOGREPS-UK 20210303 at 15 UTC from 20210303 at 00 UTC
paintball over 1 mm over 3 hours



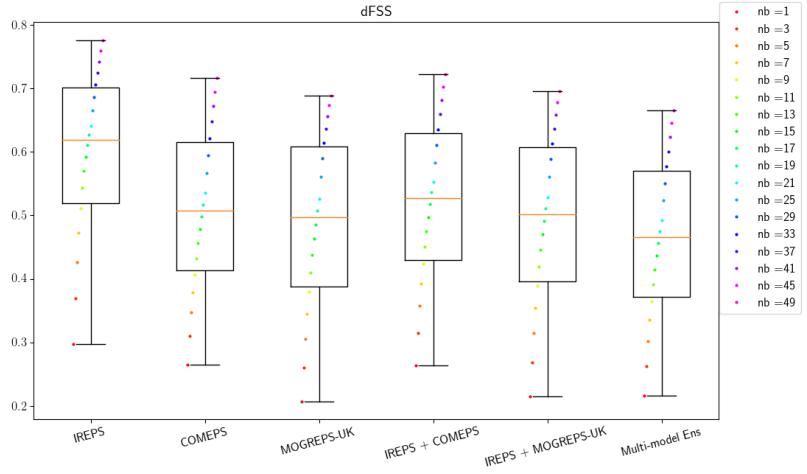

Radar accumulation over 3 hours valid at 20210303 15 UTC

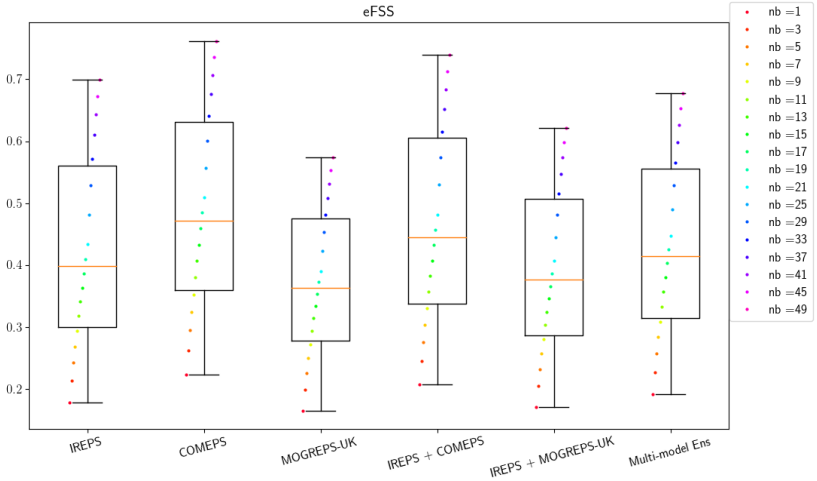


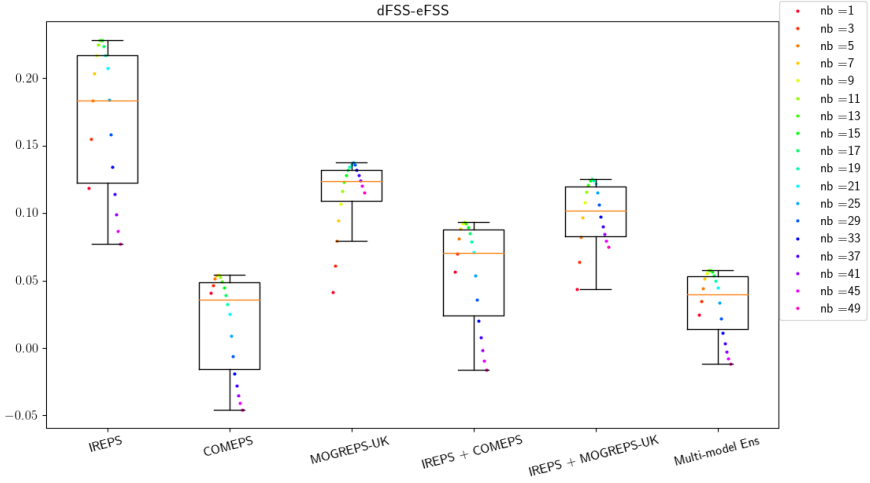

Prob 3 hourly Rain Accum 1.0 (mm)
20210303 at 15 UTC from 20210303 at 00 UTC



# FSS metrics. Validity= 18 UTC, threshold =1 mm




IREPS and MOGREPS-UK are less well balanced ensembles than COMEPS (i.e., in terms of spread) as well as multi-model ensembles including COMEPS. Note IREPS+MOGREPS-UK also well balanced ensemble

# Conclusions

- The focus of the analysis is on extracting the *benefits* of using ensemble datasets *for use in operational guidance*
- 16 cases to review. First analysis shows that the benefits are estimated as high.
- Our main objectives are to continue to:
  - Benchmark the skill and the spread-to-skill relationship for high-profile cases
  - Qualify differences in the characteristics of the  spread regarding organisation and fragmentation as well as inform our research development process
  - Characterise the benefits of combining different ensembles via multi-model ensembles
  - Use the dataset as a benchmark to other ensemble design such as multi-physics ensembles

# Challenges and opportunities

- Accessing other ensembles carries with it the need to review/adapt the communication and guidance to operational meteorology to take in 1) the impact of changes to other operational systems 2) the differences in model characteristics compared to the UM systems
- This might require 1) tighter communication and collaboration between operational centres to report on the respective benefits and disadvantages 2) additional monitoring efforts
- But this in turn can result in further update on the quality of the UM systems through better science and operational system developments

Met Office

# Thank you for your attention

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Operations to Research